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International Geomagnetic Reference Fields: DGRF 1965, DGRF 1970, DGRF 1975, and IGRF 1980

IAGA Division 1
Working Group 1

U.S. Geological Survey
Denver, Colorado

The International Geomagnetic Reference Field (IGRF) 1965 was the first of such reference fields and was adopted by the International Association of Geomagnetism and Aeronomy (IAGA) in 1968 [*IAGA Commission 2 Working Group 4*, 1969]. It consists of a model of the main field at 1965.0 along with a model of secular variation for use in extending the main field model in time, both backward (not earlier than 1955.0) and forward (not later than 1975.0). IGRF 1975, adopted later, consists of IGRF 1965 extended to 1975.0, along with a revised model of secular variation for use in extending the main field model up to 1980.0 [*IAGA Division 1 Study Group*, 1976].

By the late 1970's, the cumulative effect of the inevitable uncertainties in the secular variation models had led to unacceptable inaccuracies in the IGRF. To satisfy the need for an accurate international geomagnetic reference field, this working group recommended the following additions:

(1) an international geomagnetic reference field for the interval 1980.0 to 1985.0 (IGRF 1980), consisting of a model of the main field at 1980.0 along with a model of secular variation for use in extending the main field model up to 1985.0;

(2) a definitive international geomagnetic reference field (DGRF) for the interval 1965.0 to 1975.0, consisting of models of the main field at 1965.0 (DGRF 1965), 1970.0 (DGRF 1970), and 1975.0 (DGRF 1975), with linear interpolation of the model coefficients for intervening dates;

(3) a provisional international geomagnetic reference field for the interval 1975.0 to 1980.0 (PGRF 1975), defined to be the linear interpolation of DGRF 1975 and IGRF 1980 (main field).

The working group also recommended that the pattern of these additions should be followed in future updates.

The recommendations, proposed as Resolution 13, were adopted by IAGA on August 15, 1981, at the Fourth Scientific Assembly at Edinburgh.

IGRF 1980 is discontinuous with IGRF 1975 at 1980.0. DGRF, unlike IGRF, results from retrospective analysis. Further revision of DGRF is not anticipated. PGRF 1975 now supersedes IGRF 1975. PGRF 1975 will be superseded if and when a definitive model of the main field at 1980.0, different from IGRF 1980, is adopted.

DGRF 1965, DGRF 1970, DGRF 1975, and IGRF 1980 (including the secular variation forecast model) are given in the form of spherical harmonic expansions whose coefficients are listed in the table below. Each main field model has 120 coefficients (10th degree and order). The secular variation forecast model has 80 coefficients (8th degree and order). The coefficients are Schmidt quasi-normalized [*Chapman and Bartels*, 1940] and refer to a radius of 6371.2 km. For converting geographic coordinates to spherical polar coordinates the use of the international ellipsoid is recommended: equatorial radius 6378.160 km and flattening factor 1/298.25 [*International Astronomical Union*, 1966].

For information about the availability of the coefficients in computer-readable form and computer programs for synthesizing field values, contact World Data Center A for Rockets and Satellites, Code 601, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA; World Digital Data Center C1, Geomagnetism Unit, Institute of Geological Sciences, Murchison House, West Mains Road, Edinburgh EH9 3LA, United Kingdom; or World Data Center A, National Oceanic and Atmospheric Administration, EDIS/NGSDC (D62), 325 Broadway, Boulder, CO 80303, USA.

The working group consisted of the following members: N. W. Peddie (chairman), D. R. Barraclough (vice-chairman), N. P. Benkova, E. B. Fabiano, B. R. Leaton, F. J. Lowes, W. Mundt, R. D. Regan, S. P. Srivastava, R. Whitworth, D. E. Winch, T. Yukutake, and D. P. Zidarov. The working group was assisted by the following consultants: L. R. Alldredge, F. S. Barker, R. L. Coles, E. Dawson, P. Hood, R. A. Langel, S. R. C. Malin, and R. Thompson. D. I. Gough was chairman of IAGA Division 1.

References

Chapman, S., and J. Bartels, *Geomagnetism*, vol. 2, pp. 611–612, Oxford University Press, New York, 1940.
IAGA Commission 2 Working Group 4, International geomagnetic reference field 1965.0, *J. Geophys. Res., 74*, 4407–4408, 1969.
IAGA Division I Study Group, International geomagnetic reference field 1975, *Eos Trans. AGU, 57*, 120–121, 1976.
International Astronomical Union, *Int. Astron. Union Gen. Assem. 12th 1964, B*, 594–595, 1966.

Working Group 1 of IAGA Division 1 deals with the topic 'Analysis of the Main Field and Secular Variations.' The interests of its members include the theory and practice of geomagnetic analysis and modeling, the theory of the origin of planetary magnetism, and the practical applications of geomagnetic field models. Peddie and Fabiano are with the U.S. Geological Survey in Denver, Colorado. Barraclough and Leaton (now retired) are with the Institute of Geological Sciences in Edinburgh, U.K. Benkova is with the Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation (IZMIRAN) in Moscow, USSR. Lowes is with the University of Newcastle-upon-Tyne, U.K. Mundt is with the Central Earth Physics Institute in Potsdam, German Democratic Republic. Regan is with Barringer Resources in Denver, Colorado. Srivastava is with the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, Canada. Whitworth is with the Bureau of Mines Mineral Research in Canberra, Australia. Winch is with the University of Sydney, Australia. Yukutake is with the University of Tokyo, Japan. Zidarov is with the Geophysical Institute in Sofia, Bulgaria.

Spherical Harmonic Coefficients of the International Geomagnetic Reference Field 1980

			DGRF			IGRF	
	n	*m*	1965, nT	1970, nT	1975, nT	1980, nT	1980–85, nT/yr
g	1	0	-30334	-30220	-30100	-29988	22.4
g	1	1	-2119	-2068	-2013	-1957	11.3
h	1	1	5776	5737	5675	5606	-15.9
g	2	0	-1662	-1781	-1902	-1997	-18.3
g	2	1	2997	3000	3010	3028	3.2
h	2	1	-2016	-2047	-2067	-2129	-12.7
g	2	2	1594	1611	1632	1662	7.0
h	2	2	114	25	-68	-199	-25.2
g	3	0	1297	1287	1276	1279	0.0
g	3	1	-2038	-2091	-2144	-2181	-6.5
h	3	1	-404	-366	-333	-335	0.2
g	3	2	1292	1278	1260	1251	-0.7
h	3	2	240	251	262	271	2.7
g	3	3	856	838	830	833	1.0
h	3	3	-165	-196	-223	-252	-7.9
g	4	0	957	952	946	938	-1.4
g	4	1	804	800	791	783	-1.4
h	4	1	148	167	191	212	4.6
g	4	2	479	461	438	398	-8.2
h	4	2	-269	-266	-265	-257	1.6
g	4	3	-390	-395	-405	-419	-1.8
h	4	3	13	26	39	53	2.9
g	4	4	252	234	216	199	-5.0
h	4	4	-269	-279	-288	-298	0.4
g	5	0	-219	-216	-218	-219	1.5
g	5	1	358	359	356	357	0.4
h	5	1	19	26	31	46	1.8
g	5	2	254	262	264	261	-0.8
h	5	2	128	139	148	149	-0.4
g	5	3	-31	-42	-59	-74	-3.3
h	5	3	-126	-139	-152	-150	0.0
g	5	4	-157	-160	-159	-162	0.2
h	5	4	-97	-91	-83	-78	1.3
g	5	5	-62	-56	-49	-48	1.4
h	5	5	81	83	88	92	2.1
g	6	0	45	43	45	49	0.4
g	6	1	61	64	66	65	0.0
h	6	1	-11	-12	-13	-15	-0.5
g	6	2	8	15	28	42	3.4
h	6	2	100	100	99	93	-1.4
g	6	3	-228	-212	-198	-192	0.8
h	6	3	68	72	75	71	0.0
g	6	4	4	2	1	4	0.8
h	6	4	-32	-37	-41	-43	-1.6
g	6	5	1	3	6	14	0.3
h	6	5	-8	-6	-4	-2	0.5
g	6	6	-111	-112	-111	-108	-0.1
h	6	6	-7	1	11	17	0.0
g	7	0	75	72	71	70	-1.0
g	7	1	-57	-57	-56	-59	-0.8
h	7	1	-61	-70	-77	-83	-0.4
g	7	2	4	1	1	2	0.4
h	7	2	-27	-27	-26	-28	0.4
g	7	3	13	14	16	20	0.5
h	7	3	-2	-4	-5	-5	0.2
g	7	4	-26	-22	-14	-13	1.6
h	7	4	6	8	10	16	1.4
g	7	5	-6	-2	0	1	0.1
h	7	5	26	23	22	18	-0.5
g	7	6	13	13	12	11	0.1
h	7	6	-23	-23	-23	-23	-0.1
g	7	7	1	-2	-5	-2	0.0
h	7	7	-12	-11	-12	-10	1.1
g	8	0	13	14	14	20	0.8
g	8	1	5	6	6	7	-0.2
h	8	1	7	7	6	7	-0.1
g	8	2	-4	-2	-1	1	-0.3
h	8	2	-12	-15	-16	-18	-0.7
g	8	3	-14	-13	-12	-11	0.3
h	8	3	9	6	4	4	0.0
g	8	4	0	-3	-8	-7	-0.8
h	8	4	-16	-17	-19	-22	-0.8
g	8	5	8	5	4	4	-0.2
h	8	5	4	6	6	9	0.2
g	8	6	-1	0	0	3	0.7
h	8	6	24	21	18	16	0.2
g	8	7	11	11	10	7	-0.3
h	8	7	-3	-6	-10	-13	-1.1
g	8	8	4	3	1	-1	1.2
h	8	8	-17	-16	-17	-15	0.8
g	9	0	8	8	7	6	
g	9	1	10	10	10	11	
h	9	1	-22	-21	-21	-21	
g	9	2	2	2	2	2	
h	9	2	15	16	16	16	
g	9	3	-13	-12	-12	-12	
h	9	3	7	6	7	9	
g	9	4	10	10	10	9	
h	9	4	-4	-4	-4	-5	
g	9	5	-1	-1	-1	-3	
h	9	5	-5	-5	-6	-7	
g	9	6	-1	0	-1	-1	
h	9	6	10	10	10	9	
g	9	7	5	3	4	7	
h	9	7	10	11	11	10	
g	9	8	1	1	1	2	
h	9	8	-4	-2	-3	-6	
g	9	9	-2	-1	-2	-5	
h	9	9	1	1	1	2	
g	10	0	-2	-3	-3	-3	
g	10	1	-3	-3	-3	-4	
h	10	1	2	1	1	1	
g	10	2	2	2	2	2	
h	10	2	1	1	1	1	
g	10	3	-5	-5	-5	-5	
h	10	3	2	3	3	2	
g	10	4	-2	-1	-2	-2	
h	10	4	6	4	4	5	
g	10	5	4	6	5	5	
h	10	5	-4	-4	-4	-4	
g	10	6	4	4	4	3	
h	10	6	0	0	-1	-1	
g	10	7	0	1	1	-2	
h	10	7	-2	-1	0	-2	
g	10	8	2	0	0	4	
h	10	8	3	3	3	3	
g	10	9	2	3	1	3	
h	10	9	0	-1	-1	-1	
g	10	10	0	-1	-1	0	
h	10	10	-6	-4	-5	-6	

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Cover. The segment of the San Andreas fault between the San Gabriel Mountains (bottom left) and the Tehachapi Mountains (on horizon, top right); the view is to the northwest. This segment, part of the 'Big Bend' of southern California, has been locked since the 1857 Fort Tejon earthquake, and was the location of the anomalous 'Palmdale bulge.' It is considered a prime possibility for future seismicity.

The picture was taken from a commercial airliner by P. D. Lowman in 1966; the area is shown on LANDSAT pictures included in 'A global tectonic activity map with orbital photographic supplement,' *NASA Tech. Memo. 82073*, 1981, by P. D. Lowman, available from the author.

News

New Nuclear Power Sources

Nuclear electric-power generation sources for the future include two viable candidates as viewed now: the fast breeder and the nuclear fusion reactors. Breeder reactors, which produce more radioactive fuels than they consume, are in the realm of existing technology. They are also categorized as potentially most harmful to the environment. Nuclear fusion reactors, on the other hand, will not be available in this century, based on current levels of development. However, they will be categorized as inherently much safer and thus potentially least harmful to the environment of all fueled electric-power generators.

Geophysicists' concern about the impact on the environment of the two new types of nuclear electric-power generation ranges from the processing of mineral ores for nuclear fuels to operation of the reactors and to reprocessing and disposal of hazardous wastes. Of simultaneous general concern is the amount of weapons-grade nuclear material produced by generating plants that could get into the wrong hands.

At this time the new era of nuclear power generation, in the development of the fast-breeder reactor and of nuclear fuels processing, is proceeding at record speed in Europe, Russia, and Japan. Knowledge of the risks to the environment has not been a barrier. The United States, by decree of President Carter, has had construction of the Clinch River breeder reactor on 'hold' for 4 years, but design and procurement of assemblies has continued, funded by Congress. Also in the United States, research on fusion reactors is being increased, thus, the assessment of environmental risks is now critical. According to K. O'Banion of the Lawrence Livermore National Laboratory (*Environmental Science & Technology*, October 1981), 'The problem is that we have no operating experience with commercial-scale [fusion reactors and fast-breeder reactors] and thus no actual data on which to have estimates of risk.'

Present-day operating fission reactors are mostly 'light-water' reactors, in which enriched uranium fuel is shielded from medium-energy neutrons (that could halt the heat-releasing nuclear chain reaction in uranium). By contrast, the fast-breeder reactor uses the more fissile fuel plutonium (^{239}Pu) plus uranium (^{238}U) surrounded by a blanket of uranium. The plutonium fissions and heat is produced. The uranium also fissions (^{238}U captures a neutron, becomes ^{239}U, and decays to ^{239}Pu) and produces plutonium plus heat. The ratio of plutonium created to that destroyed is greater than 1. Thus the fast-breeder reactor is highly efficient to the point that expenditure of fuel will be no consideration. This unusual efficiency contributes to the risks of the breeder reactor. There are numerous radioactive nuclear fragments formed when plutonium fissions.

A significant part of the operational cycle of a fast breeder reactor is fuel reprocessing. The core and surrounding blanket must be removed from the reactor and reprocessed to extract fission products (which must be stored safely for tens of thousands of years) and to recycle plutonium and uranium for fuel. There would be no point in building and operating a fast-breeder reactor if reprocessing of the fuel were not part of the cycle, so the current political impetus in the United States to proceed with the Clinch River reactor is, according to O'Banion, '. . . a de facto decision to lift the U.S. moratorium on reprocessing and, as a consequence, put large amounts of weapons-grade plutonium into circulation within the U.S.' He points out that in normal operation and recycling the flow of plutonium in a breeder reactor rated at 1000 MW would be expected to be more than 1500 kg-yr. To centralize processing and keep the weapons-grade material in a protected zone would require an enormous facility, one that would release so much heat into the atmosphere that a permanent change in local weather patterns would ensue. The alternatives include transporting spent fuel and weapons-grade material between several tens of reactors and reprocessing and fabrication plants.

The fusion reactors are unknown in practice, but as opposed to breeder reactors, the principles are such that a lot lower level of risk is involved. No weapons-grade material is produced, and radioactive materials and wastes are relatively low. In the fusion reactor the primary fuel is deuterium. The reaction that releases heat is the controlled nuclear fusion of deuterium with tritium, producing helium. Neutrons released in the reaction are absorbed by a lithium blanket, and heat is released. The fuel is first heated to the ionized plasma state at about 10^8 K. The fuel must be isolated either by magnetic field confinement (as in the currently planned designs) or by inertial confinement to maintain the plasma state.

The dangerous radioactive materials in a fusion reactor include only tritium (tritium is both used up and formed in the process, so once the reactor starts up, no additional tritium is needed) plus the parts of the reactor structure whose components become activated and thus radioactive. The high-energy neutron flux in a fusion generator is mostly absorbed by the reactor process, but the reactor itself absorbs some, and neutron bombardment not only produces radioisotopes by activation but weakens the structure. Parts of the structure will have to be replaced periodically, and like other radioactive waste, must be stored confined for thousands of years.

The release of hazardous radiation and radioactive vapors and products of the new generation of reactors into the atmosphere and elsewhere will be carefully monitored. The problems for geophysicists concerned with radioactive waste storage above and below ground and on the ocean floor will increase with the new generation.—*PMB*

Women Ph.D.'s Careers Lag Men's

Numerous studies of male and female Ph.D.'s have found wide differences in academic rank and pay. Now a study by a National Research Council committee debunks the traditional reasons given to explain the disparity. This study, which analyzed matched triads of Ph.D.'s, concluded that neither the perceived greater restraints on the career mobility of women nor the greater likelihood that women will interrupt their careers for child rearing explains adequately the differences between male and female Ph.D.'s. Discrimination appears to be the most likely root.

When male and female Ph.D.-holding faculty are matched by years of experience, academic field, and educational background, females are less likely to advance in rank and are likely to earn lower salaries than their male colleagues, according the 'Career Outcomes in a Matched Sample of Men and Women Ph.D.'s,' an analytical report by the Committee on the Education and Employment of Women in Science and Engineering. This matching—of two men and one woman into 5164 groups—removed a large part of the variability between the male and female population, states the report, authored by Nancy C. Ahern and Elizabeth L. Scott.

'Objective factors alone cannot account adequately for the career differences which exist between male and female Ph.D.'s,' the report said. Among the study's findings:

- Of the 1318 women who earned their doctorates between 1970 and 1974, about two thirds were married, but less than half had children. Only one tenth of the women with children were not working in 1979. Married women with children were just as likely as unmarried women with no children to have senior faculty rank.
- In promotions of junior faculty, women lagged behind men, regardless of marital status, presence of children, or their primary orientation toward research or teaching.
- Female assistant professors who changed employers between 1975 and 1979 did not materially improve their status, while men who moved did. Women faculty were more likely than men to have changed employers during those 4 years—28% compared to 19%.
- Females' salaries at major research universities are significantly below the estimated salaries for men with similar characteristics. The estimations account for such work-related variables as full-time status, primary activity, and type of institution where employed. The study does not, however, include measures of research productivity.
- There is no evidence for reverse discrimination in obtaining employment. Even for Ph.D. recipients between 1975 and 1978, involuntary unemployment was two and a half times higher for women than for men.
- One quarter of the recent female Ph.D.'s hold academic positions that are nontenure track; the rate for matching males is 15%.
- Among those who received their Ph.D.'s in the 1940's and 1950's, 87% of the men are full professors; 64% of the women in the category have attained such heights on the academic ladder. In this same category, women earned, on average, 11% less than men. Females who earned their doctorates after 1975 fare not much better: Depending on field, men's salaries are between 2% (mathematics) and 15% (chemistry) higher than women's salaries. Figures for earth sciences were not reported because of a small sample size.—*BTR*

Solar Neutrinos Captured at Homestake

The nuclear fusion processes in the sun are not clearly understood, but solar geophysicists Ray Davis, of the Brookhaven National Laboratory, and Ed Fireman, of the Smithsonian Institution, are improving on physical models of solar processes by studying the solar neutrino flux. They are doing this by capturing neutrinos and analyzing them with apparatus located a mile below the earth's surface in the Homestake gold mine in South Dakota.

This study has led recently to a few surprise findings related to fundamental properties of both the solar system and matter. The flux rate of solar neutrinos is closely tied to the fusion rates and thus the solar system release of energy. The rates are also a measure of the ultimate stability of matter in the universe, the ultimate loss of mass.

The measurements are done in the deep gold mine to avoid interference in the analysis by other, less energetic, processes. High-energy electron neutrinos released from the sun's interior travel fast to the earth and penetrate. The analysis involves monitoring the decay of ^{37}Ar, formed from ^{37}Cl that was activated by a neutrino. Ray Davis achieves this by storing a tank filled with 100,000 gallons of chlorine-rich dry-cleaning fluid (tetrachloroethylene) in the mine and counting the argon decay reaction. These counts are then compared with theoretical solar models. According to a recent report by the Smithsonian Institution (*Smithsonian Research Reports*, Autumn 1981):

> The best theoretical prediction for the solar neutrino flux suggests two atoms per day should be seen, but the experimental counting rate in the mine tank is only one atom every other day, or about three to four times less than predicted. The missing neutrinos once caused some concern among solar physicists, for they implied there was something wrong with the theory about how the sun produces its energy. However, the new 'gauge theories' explain the discrepancy by suggesting that the solar neutrinos change into three distinct types during their eight-minute travel life from the sun. Thus, the tank experiment is successfully detecting the one-in-three solar neutrinos reaching Earth.
>
> The 'gauge theories' explain the instability of all matter. For example, atoms heavier than hydrogen disappear proportionately faster; according to the Smithsonian report, the theories calculate '. . . the rate [of disintegration] one potassium atom in every 2.5×10^{32} atoms, some 160 tons of potassium, may disappear each year.' Davis' colleague, Ed Fireman of the Smithsonian, is testing some of these possibilities by studying nuclear decay reactions in a 2-ton mass of potassium salt stored in a mine railway tank car located right next to the dry-cleaning fluid tank. The ^{37}Ar production in potassium is not caused by neutrino interaction but by energetic muons whose origin is the cosmic ray flux that impinges upon the earth's surface. Cosmic ray muons produce some of the heavy argon in Davis' tank, so the results from the potassium mass can be used to determine 'background' argon. David finds that after subtraction of the cosmic ray muon-produced background his counts include about 85% heavy argon, produced by solar neutrinos.

Davis says that the new results allow the possible interpretation provided by the 'unified gauge theory' and the recent idea that neutrinos have mass. He cautions, however, that a slightly more likely explanation is that the solar model may require revision.

Fireman has now placed an additional tank car of potassium hydroxide in the gold mine to improve accuracy. According to the report:

> To refine the counting technique, Fireman has installed in the mine a second tank car filled with potassium hydroxide, or common lye. In addition to obtaining a more accurate value for the cosmic-ray correction to the solar-neutrino experiment, Fireman hopes to develop the technology for a large-scale radiochemical test of the stability of matter itself, which may be the most important implication of the 'gauge theories.'—*PMB*

Special Report: Krafla Volcano

Careful study of a series of intrusions and eruptions at Krafla has added substantially to our understanding of processes at rifting plate boundaries. During more than a dozen deflation events between 1975 and 1979, most of the magma that left the shallow reservoirs beneath Krafla formed dikes in the fissure zone extending north and south of the caldera, with only minor amounts reaching the surface in associated eruptions. The character of Krafla's activity changed in 1980, and the largest eruptions since the rifting episode began in 1975 were associated with events in July and October 1980 and January–February 1981.

Krafla Caldera, Myvatn Area, Iceland (65.73°N, 16.68°W). All times are GMT. After more than 9 months without an intrusive event or eruption at Krafla, instruments recorded the simultaneous onset of deflation and harmonic tremor at 0036 on November 18, followed by the start of a fissure eruption at 0152. Between 0400 and 0500, geologists flew over the active fissure and observed vigorous lava fountaining, feeding flows that had advanced as much as 5 km to the west. Rates of lava extrusion along the fissure varied but were probably the most voluminous seen since activity began in December 1975. Extrusion occurred along the entire fissure, which extended from near the center of the caldera about 8 km to the north (the October 1980 fissure vents were in almost the same location but stopped about 1 km north of the southern end of the November 1981 fissure). Strong northerly winds blew some scoria onto the nearby power station, but no damage occurred. Discrete earthquakes initially accompanied harmonic tremor but stopped after a few hours. By 1000, lava extrusion had weakened considerably and was confined to three 1-km-long segments of the fissure. Inflation resumed November 22, but minor eruptive activity continued. Lava extrusion stopped early November 23, but late that afternoon occasional minor spattering resumed. Initial reconnaissance mapping indicates that lava flows covered 16–20 km^2 and that the longest flow traveled roughly 6 km from the fissure.

Krafla last erupted January 30–February 4 from fissure vents 8–9 km north of the caldera. Inflation resumed as the eruption ended and continued until just before the November eruption. During previous periods of inflation, the tilt data were consistent with a single center of uplift beneath the caldera, but since February 4 the deformation pattern has been more complex and may indicate multiple centers of uplift.

Information contact: Karl Grönvold, Nordic Volcanological Institute, University of Iceland, Reykjavik, Iceland.

Forum

Magnetic Monopoles Redux

In connection with the most interesting note by J. C. Cain (*Eos*, September 22, 1981) on the possibility that g_0^0 does not vanish, it is worth remembering that the suggestion of searching for a nonzero value goes back to Gauss, considerably before Vestine (and Dirac!). In his *Allgemeine Theorie des Erdmagnetismus* (1839), Gauss wrote:

> The question remains whether or not a detectable surplus of one or other kind of 'fluid' (i.e., magnetic pole) exists in an isolated magnetic body. . . .
>
> In our theory, the only effect of such a nonequality would be that P^0 (i.e., g_0^0) would no longer equal 0. In the future when a much more abundant set of observations is available, it may be possible to determine whether or not a nonvanishing value of P^0 is required. . . .

Magsat would appear to have provided the observations so wished for by Gauss.

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Department of Physics
University of Toronto

With regard to Joseph Cain's query in Forum on magnetic monopoles: could they add up to an observable g_0^0 for the earth? I refer him and other physicists interested in this to a paper of mine (*Phys. Rev. D.*, *8*, 2245, 1970), wherein I searched for magnetic monopoles in the moon, using Norman Ness' Explorer 35 (anchored IMP) magnetometer data. It was shown that any net lunar magnetic monopoles would influence the magnetic field in the lunar wake, and a scheme was developed to compare the lunar wake field with the undisturbed interplanetary field. The search resulted in negative findings and placed the upper limit on the average difference in the number of monopoles within the moon at 1.6×10^{-7} cm^{-3} or 7×10^{-32} per nucleon. This probably represents the lowest value per nucleon established anywhere, insofar as an entire astronomical body was examined. With regard to the terrestrial test Joe Cain suggested, the large terrestrial field implies that the moon would be a better test object, however the earth's field is better mapped.

Kenneth H. Schatten
Laboratory for Planetary Atmospheres
NASA/GSFC

New Publications

Resolution Numérique D'une Equation de Diffusion Non Lineaire

M. Vauclin, R. Haverkamp, and G. Vachaud, Presses Universitaires de Grenoble, Grenoble, France, 183 pp. 1979.

Reviewed by J. W. Delleur

Numerical methods make it possible to solve complex problems of subsurface hydrology without resorting to mathematical simplifications that may be necessary for closed-form solutions but are physically unrealistic. The ever increasing capabilities of digital computers make these numerical simulation models increasingly attractive to researchers and engineers. The prediction of the water flow in the unsaturated zone between the atmosphere and the water table requires a reliable numerical model that has a reasonable utilization cost. This book is concerned with the problems associated with these numerical simulation models. It is more specialized than its American counterpart, *Numerical Methods in Subsurface Hydrology*, by I. Remson, G. M. Hornberger, and F. J. Molz (Interscience, New York, 1971), which is also concerned with saturated media and includes an introduction to the finite element method. The book under review is limited to the application of the finite difference method to the several forms of the differential equation for the vertical movement of water in the unsaturated zone. This differential equation is nonlinear and difficult to solve because of the dependence of the parameters—the hydraulic conductivity, the capillary potential, and the capillary diffusivity—on the soil moisture content. Numerical solutions are, therefore, frequently substituted for exact solutions that are difficult to obtain or nonexistent.

The main contribution of this book is its emphasis on the convergence and stability properties for the several basic equations taking into account the nature of the discretization scheme and the treatment of the nonlinearities. The book is written in a very concise style, and the majority of the mathematical and technical terms are very similar in French and English, which makes the book quite readable even for those with a limited knowledge of French.

In Chapter I the basic equations for water transfer are developed. These are the 'local budget model,' which considers the water mass conservation in a soil element; the 'decomposed model,' which separates the diffusive and convective aspects of the water movement in soil; and the 'Kirchhoff model,' based on the flow potential $U(h)$ or the Kirchhoff transformation

$$U(h) = \int_{h_0}^{h} K(h)\, dh$$

where K is the hydraulic conductivity and h is the effective pressure (suction) head. All equations are treated in a dimensionless form. The well-known quasi analytic solution of Philip [*Australian J. Phys.*, 1957] is used as a standard of comparison to evaluate the performances of most of the numerical finite-difference schemes found in the literature and of some new ones. Experimental results are also used for comparison purposes.

Chapter II is concerned with the linear case that is obtained by assuming the capillary capacity ($C = d\theta/dh$, where θ is the moisture content and h is the effective pressure head) and the hydraulic conductivity, K, remain constant. This case provides a lower bound of the discretization parameter $M = \Delta t/\Delta z^2$. Even in the linear case the finite difference schemes perform better asymptotically than they do during the transient, owing to a unit step change in equilibrium condition.

Chapter III lists 40 finite difference discretization schemes of the three basic nonlinear differential equations. The problems associated with the numerical integration are set forth: (1) the choice between the explicit, implicit, and Crank-Nicolson schemes; (2) the problem of linearization or the choice of the value that C takes between t and $t + \Delta t$; (3) the choice of the value of K at time $t + \Delta t$ (for the implicit schemes); (4) the problem of weighting or choosing the value of K at the points $z + \Delta z/2$ and $z - \Delta z/2$; (5) the convergence of the discrete operator to the differential operator; and (6) the choice of the initial model.

Chapters IV and V present a critical analysis of the convergence of the numerical solutions of the infiltration equation in unsaturated Yolo light clay and in sand for surface conditions of infiltration by ponding (head condition) and by rainfall or sprinkler irrigation (constant flux condition). The effects of weighting and linearization on the truncation errors are analyzed for the several schemes. For the head condition, numerous graphs exhibit the time variation of the relative error between the Philip and the numerical solutions obtained at different depths, for different mesh sizes for the several schemes. Theoretical truncation errors generated by the different schemes are tabulated. In addition to the accuracy of the solution, the cost or computer time associated with these solutions is considered. Several diagrams give the error in the infiltrated volume and the computing time (IBM 360/67 with 32 bits words) as a function of the discretization parameter M for the better schemes. For the case of constant flux there is no known exact solution that can be used for reference. The influence of the weighting scheme is shown in graphs that exhibit the relative water budget as a function of time for different mesh sizes for several numerical schemes.

Chapter VI is concerned with the application of the local budget model to the simulation of infiltration in a stratified medium and the comparison with experimental results.

Several important conclusions follow from this study: certain published schemes yield unacceptable errors, the weighting mode has a great importance on the numerical solution, the effect of linearization is different among the different discretization types, the analysis of truncation errors elucidates the behavior of the different schemes, the finite difference schemes are better adapted to the asymptotic behavior than to the transient behavior, and the numerical schemes that are stable and give the same asymptotic behavior may give different transient solutions. Thus, for problems involving coupled transfer (such as water and pollutant or water and heat) it is important to choose a model with small errors in the kinetic behavior.

Two appendices give the details of the discretization schemes and a computer program for the quasi-analytic solution of Philip.

This book is not written as a textbook in subsurface hydrology but is intended to give the user of numerical models very important information on the mode of application and the performances to be expected from the several numerical schemes. In addition to the extensive list and comparison of models found in the literature, some new ones are presented. These models and comparisons have been developed by the authors and their graduate students during recent research on the subject at the Institute of Mechanics of the Scientific and Medical University of Grenoble, France.

The book is an essential reference for those concerned with the numerical solution of subsurface hydrology. It is of invaluable assistance in avoiding unsuitable methods that may not converge, may become unstable, or may require excessive computer time. It will also assist the user in choosing from the stable and convergent solutions one that has tolerable error and that requires reasonable computer time for the problem.

J. W. Delleur is with the School of Civil Engineering, Purdue University, West Lafayette, Indiana.

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EOS offers classified space for Positions Available, Positions Wanted, and Services, Supplies, Courses, and Announcements. There are no discounts or commissions on classified ads. Any type that is not publisher's choice is charged for at display rates. EOS is published weekly on Tuesday. Ads must be received in writing on Monday 1 week prior to the date of the issue required.

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University of North Carolina at Charlotte: Faculty Position in Earth Sciences. The Department of Geography and Earth Sciences offers an interdisciplinary major in Earth Sciences, which includes a geology track and a developing focus on water resources. The department is seeking to fill a tenure track faculty position at the assistant professor level to begin July 1982.

Stratigrapher/Sedimentologist—To teach stratigraphy, sedimentary processes and historical geology as well as introductory level Earth Science courses and to contribute to research and service activities. Ph.D. required for tenure track appointment. Others with substantial doctoral coursework and experience will be considered for lecturer appointment.

Send a letter explaining your interest, along with a current vitae, to Alfred W. Stuart, Chairman, Department of Geography and Earth Sciences, UNCC Station, Charlotte, NC 28223. Phone: 704-597-2293. Closing date for initial application is January 11, 1982.

AA/EO employer.

Research Associate/Electron Microprobe. The Electron Microscopy Center at Texas A&M University invites application for the position of Electron Microprobe Specialist. Applicants should possess a working knowledge of WDS and EDS spectrometers and accompanying computer and software programs and preferably have had experience in the Geological Sciences.

The primary duties of the position are to oversee and maintain (with the aid of service contracts) the electron microprobe and ancillary equipment and to assist in teaching graduate course laboratories dealing specifically with electron microprobe analysis. Salary will be up to $25,000/12 months.

Applicant should send supporting data and letters of recommendation to:

Dr. E. L. Thurston
Texas A&M University
Biological Sciences Building
College Station, Texas 77843

Texas A&M is an equal opportunity/affirmative action employer.

Faculty Position in Geophysics/Structural Geology/Engineering Geology. The Department of Geological Sciences at Case Western Reserve University in Cleveland, Ohio is seeking candidates to fill an anticipated faculty position in the broadly defined areas of geophysics/structural geology/engineering geology. While field of specialization is open, the successful candidate will be charged with conducting the Department's teaching programs in geophysics at the graduate and undergraduate levels, in addition to carrying out a vigorous research program. Ample opportunities exist for research collaboration both within the Department of Geological Sciences and with faculty members in the School of Engineering.

Ph.D. or equivalent is required. Please submit applications, consisting of résumé, names of three references and a statement of research and teaching interests to:

Samuel M. Savin
Department of Geological Sciences
Case Western Reserve University
Cleveland, Ohio 44106.

Case Western Reserve University is an equal opportunity/affirmative action employer.

Faculty Position/ASU. The Department of Chemistry at Arizona State University invites applications for a possible tenure track position at the assistant professor level in one of the following areas: (1) Synthetic Solid State Chemistry; (2) Surface Chemistry; and (3) Atmospheric or Low-Temperature Geochemistry. Candidates should have demonstrated in their Ph.D. and/or postdoctoral work the ability to develop a vigorous and innovative research program in one or more of the above areas and have a commitment to instructional excellence. A resume, brief description of research plans, and three letters of recommendation should be sent to Professor William S. Glaunsinger, Chairman, Search Committee, Department of Chemistry, Arizona State University, Tempe, Arizona 85287.

EO/AA employer

Petrology/Geochemistry: Florida International University. Applications are invited for one tenure track position (assistant professor) available from August 1982. The successful candidate will be expected to teach at the undergraduate level and pursue a vigorous research program. The applicant should have a background in petrology and geochemistry. Highly qualified candidates in the areas of geophysics or hydrogeology may also be considered. Applicants should have a Ph.D. degree. Closing date March 15, 1982. Applications including a curriculum vitae, research interests, and three letters of reference should be sent to:

Dr. Leonard Keller, Chairman, Department of Physical Sciences, Florida International University, Tamiami Trail, Miami, Florida 33199.

FIU is a member of the State University System of Florida and is an equal opportunity/affirmative action employer.

Structural Geologist/University of Wyoming. The University of Wyoming, Department of Geology and Geophysics seeks applicants for a tenure track appointment in structural geology expected to be available beginning fall semester 1982 or earlier. Duties will include teaching of undergraduate and graduate courses in structural geology, supervising MS and PhD theses, and research in structural geology. Appointment at assistant professor level is preferred, but applicants requesting appointment at higher rank will be considered. Salary open. Applicants must have PhD degree and be versed in quantitative theory as well as field applications or modern structural geology and regional tectonics.

Applicants should provide, by January 1, 1982, a resume, three letters of reference, and a letter of application including a statement of current research interests and courses which the applicant feels qualified to teach. Applications should be sent to:

Dr. Robert S. Houston/Head
Department of Geology and Geophysics
University of Wyoming
Laramie, Wyoming 82071-3006.

The University of Wyoming is an equal opportunity/affirmative action employer.

University of Montana, Department of Geology/Two Positions: Tectonics and Paleontology. Applications are invited for two tenure track positions: tectonics with focus on western North America, and paleontology-biostratigraphy-paleoecology. Both positions begin September 1, 1982. Applicants must have the Ph.D. degree or expect completion by summer 1982. Send letter of application, resume, an outline of teaching and research interests, and other pertinent material and have at least three letters of recommendation sent to Donald W. Hyndman; Search Committee Chairman; University of Montana; Missoula, Montana 59812. Deadline for applications is March 15, 1982.

The University of Montana is an affirmative action/equal opportunity employer.

Research Associate/Theoretical Physical Oceanography. Applications invited for two postdoctoral research associate positions in the School of Oceanography, Oregon State University. Applicant will conduct research in theoretical modelling and observational comparisons of ocean circulation. Ph.D. in mathematics or the physical sciences. Submit resume, brief statement of research interests and three references by 1 January 1982 to Prof. Pearn P. Niiler, School of Oceanography, Oregon State University, Corvallis, Oregon 97331.

An affirmative action/equal opportunity employer.

Seismologist/University of Utah. Search extended: the University of Utah is expanding its geophysics program in the Department of Geology and Geophysics by adding a tenure track faculty member in seismology at the assistant to associate professor level. Applicants with backgrounds and specialties in seismic reflection, seismic imaging, and theoretical seismology will be given preference. The individual will be expected to teach undergraduate and graduate courses, and to pursue an active research program with graduate students. The department has modern teaching and research programs in geology and geophysics, and has close associations with the numerical analysis and data processing groups in computer science, electrical engineering and mathematics. The geophysics component of the department has strong research and teaching programs in seismology, electrical and electromagnetic methods, thermal properties of the earth, and potential fields. Current research in seismology includes: seismological and earthquake research utilizing a new PDP 11/70 computer with plotter and terminals; monitoring of the Intermountain seismic belt by a 55 station telemetered network utilizing a new on-line PDP 11/34 computer; major experiments in seismic refraction profiling, investigations of seismic propogation from synthetic seismograms, application of inverse theory to seismology, seismic properties of volcanic systems and allied research in tectonophysics. The closing date for applications is December 31, 1981. A Ph.D. is required for this position. Applicants should submit a vita, transcripts, a letter describing his/her research and teaching goals, and names of five persons for reference to William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112.

University of Utah is an equal opportunity/affirmative action employer.

Lehigh University. Research Associate (Post Doctoral) position involving a study of the geochemistry of meteoritic metallic phases. Solidification experiments are planned with Fe-Ni-S-P-C melts to determine partition coefficients of geochemically important minor elements—Ir, Ge, Au, etc. Goal is to investigate behavior of particular elements during the solidification of the core and mantle of asteroidal parent bodies.

The position is available after January 1, 1982. Lehigh University is an equal opportunity/affirmative action employer. Send vita and the names of three references to Professor Joseph I. Goldstein, Department of Metallurgy and Materials Engineering, Bldg. #5, Lehigh University, Bethlehem, PA 18015.

Postdoctoral Fellowship/Department of Oceanography, University of British Columbia. Available January 1, 1982 for studies of the mineralogy and geochemistry of deep ocean ferromanganese nodules and the relationships between nodules and their associated sediments. Salary $16,000. Send curriculum vitae, statement of research interests and names of three referees to: S. E. Calvert, Department of Oceanography, University of British Columbia, Vancouver, B.C., Canada V6T 1W5.

Petrologist-Economic Mineralogist/University of Oklahoma. Applications are invited for a tenure-track position, effective September 1, 1982 at the assistant professor level, in petrology and economic mineralogy. The successful applicant is expected to teach graduate courses in his/her specialty, to help teach undergraduate courses in mineralogy-optics-petrography, and to pursue an active research program. Consulting and interacting with mining companies are encouraged.

The University of Oklahoma has made a major commitment to diversify the program in the School of Geology & Geophysics. As a result five tenure-track positions are open for the fall of 1982. Six new faculty were added to the School in the fall of 1981 (bringing the total full-time faculty to 15), and an additional six positions will be available during 1983–1985. A new building that will house the School is in the design stage, and the successful applicant will participate in equipping it.

The Ph.D. degree is required for this position. Preference will be given to petrologists with a strong chemistry background and with a demonstrated interest in the economic geology of metallic and non-metallic mineral deposits. Qualified applicants should send to transcripts of all college and university work, resume, statement of research interests, and three letters of reference to: Dr. Maryellen Cameron, School of Geology and Geophysics, University of Oklahoma, Norman, Oklahoma, 73019. Deadline for applications is December 31, 1981. Faculty members from the School will be interviewing at the November G.S.A meeting in Cincinnati, Ohio, and at the December A.G.U. meeting in San Francisco, California.

The University of Oklahoma does not discriminate on the basis of race, or sex, and is an equal opportunity employer.

Geophysical Fluid Dynamicist/Physical Oceanographer. Applications are solicited for a junior faculty position in ocean physics or dynamics to begin in the academic year 1982–83. Areas of interest to the Department include analytical, numerical and laboratory modeling of physical processes and phenomena in the sea.

Yale University is an equal opportunity/affirmative action employer and encourages women and members of minority groups to compete for this position.

Curriculum vitae, publications, and the names of three or more referees should be sent by 31 December 1981 to: Robert B. Gordon, Chairman, Department of Geology and Geophysics, P.O. Box 6666, New Haven, CT 06511.

Hydrology: Tenure Track Position at Assistant or Associate Professor Level. Candidate should be a specialist in some quantitative aspect of hydrology with demonstrated skills in formulating hydrologic models, and a background in transport phenomena. Academic or professional credentials at Ph.D. level required. Starting date negotiable but could be as early as August 1982. Resumes, etc., should be received by March 1, 1982. Interested persons should request job description from: Dr. E. S. Simpson, Chairman, Search Committee, Department of Hydrology and Water Resources, University of Arizona, Tucson, Arizona 85721.

Equal opportunity/affirmative action employer.

South Dakota School of Mines and Technology. Applications are invited for two positions in the Department of Geological Engineering. Both involve teaching at undergraduate and graduate levels, thesis direction and development of research.

Geological Engineering: specialty in rock or soil mechanics, site evaluation, geohydrology, petroleum/reservoir engineering or engineering seismology. Industrial design experience helpful. A Ph.D. in some area of engineering is preferred.

Ore Deposits: area of specialization is open. The successful applicant will work closely with the newly established Institute for the Study of Mineral Deposits. The Ph.D. is required.

The Department has an undergraduate enrollment of 170 majors and a graduate enrollment of 60. Field applications of geology and engineering are emphasized. Interested persons should send a resume and three letters of recommendation to: Alvis Lisenbee, Dept. of Geology/Geological Engineering, South Dakota School of Mines and Technology, Rapid City, SD 57701.

SDSM&T is an equal opportunity employer

Princeton University/Water Resources Program, Department of Civil Engineering. Department of Civil Engineering invites applications for a tenure track, three-year appointment at the assistant professor rank beginning on or before September 1982. Responsibilities include graduate and undergraduate teaching in hydrology and water resources, and participation in research into either hydrological processes associated with infiltration and unsaturated flow or chemical processes and transport in the unsaturated zone. Candidate must have Ph.D. degree with demonstrated teaching ability and scholarship.

Submit resume and references to:

Eric F. Wood, Director
Water Resources Program
Department of Civil Engineering
Princeton University
Princeton, NJ 08544.

Princeton University is an affirmative action/equal opportunity employer.

University of Utah: Faculty Positions. The Department of Geology and Geophysics invites applications for four tenure track positions at the assistant to associate professor level.

1) *Economic Geology:* The specific area of expertise is open, however, preference will be given to candidates whose research interests are in geological, geochemical, or petrological characteristics of metallic mineral deposits.
2) *Sedimentary geology:* Applicants should have research interests in modern or ancient sedimentary basins.
3) *Seismology:* Applicants with backgrounds and specialties in seismic reflection, seismic imaging or theoretical seismology will be given preference.
4) *Potential fields:* Geophysicist with specialty in potential theory including gravity and magnetics. (The closing date for this position is January 31, 1982).

A Ph.D. or equivalent is required. The vacancies are to be filled by September 1982; the closing date for applications for positions 1–3 is December 31, 1981. Applicants should submit a vita, transcripts, a letter describing his/her research teaching goals, and names of five persons for reference to William P. Nash, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112.

The University of Utah is an equal opportunity/affirmative action employer.

Positions in Oceanography/VIMS. The Virginia Institute of Marine Science (VIMS)/School of Marine Science invites applications for two state funded, oceanography research and teaching positions at the levels of Senior Marine Scientist. VIMS is a broad-based marine science establishment with a mission to provide sound and timely advice to executive agencies and the legislature and to conduct incisive research programs. The School of Marine Science offers M.A. and Ph.D. programs with a faculty of 66 and 139 graduate students.

HEAD, DEPARTMENT OF GEOLOGICAL OCEANOGRAPHY (#113)

Applicants are sought with research interests in estuarine sedimentary geochemistry, dynamics of cohesive sediment transport, or estuarine and coastal morphodynamics. For further information contact Dr. Robert Byrne (VIMS), 804/642-2111 (Ext. 173).

ESTUARINE AND COASTAL HYDRODYNAMICS (Position #204)

A physical oceanographer with a strong interest in interdisciplinary approaches to complex estuarine and continental shelf problems is desired. For further information contact Dr. Bruce Neilson (VIMS), 804/642-6131 (Ext. 244).

Candidates for both positions should have established research credentials and be dedicated to furthering the research and educational programs of the Institute. Demonstrated ability to generate extramural support is expected. Salary range is $24,972 to $34,107 and faculty rank is commensurate with qualifications.

Applicants should send a comprehensive curriculum vita, reprints, and at least three letters of recommendation by February 1, 1982, stating specific position of interest, to: Employment Manager, Personnel Office, College of Wm & Mary, Williamsburg, VA 23185.

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Iowa State University of Science and Technology/Department of Earth Sciences.

Applications are invited for two tenure track faculty positions. The rank for each is at the assistant or associate professor level, dependent upon qualifications. The successful applicants will be expected to develop strong research and graduate student programs. Teaching duties will include undergraduate and graduate courses in the areas of expertise.

Mineral Resources Economic Geology: One position is in mineral resources/economic geology. An applied field orientation is preferred. Iowa State has established a Mining and Mineral Resources Research Institute and an interdepartmental minor in Mineral Resources in order to support and develop research and education in this area. In addition to the appointment in the Department of Earth Sciences there will be full opportunities to interact with these programs.

Geomorphology: The second position is in the general field of geomorphology. Additional expertise in an area related to geomorphology, such as groundwater, engineering geology or remote sensing is also desired. A person with an applied field orientation is being sought.

Each appointment will be on an academic year basis. Opportunities are available for summer teaching appointments. Salaries will be commensurate with qualifications. Application deadlines for both positions are February 15, 1982; later applications will be accepted if a position is not filled. Positions are both currently available and are expected to be filled no later than fall, 1982. For application information please write to:

Bert E. Nordlie
Department of Earth Sciences
253 Science I
Iowa State University
Ames, Iowa 50011

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Faculty Positions. *Two Faculty Positions in Geology.* Tenure-track positions in geology, assistant professorships. Ph.D. preferred or equivalent experience. Fall 1982.

Petrologist-Mineralogist. Candidate must be able to teach introductory geology, mineralogy, petrology, geochemistry, and optical mineralogy/petrography.

Invertebrate Paleontologist-Soft-Rock Geologist. Candidate must be able to teach courses in invertebrate paleontology, micropaleontology, sedimentation, and historical geology. Additional expertise in recent marine environments highly desirable.

Applicants are expected to do research in their areas of expertise, and to lead students' field trips. Strong teaching and research commitments expected. Submit applications with resume and copies of transcripts, and have three letters of recommendations sent to the Chairperson, Department of Earth & Space Sciences, Indiana University-Purdue University at Fort Wayne, Fort Wayne, Indiana 46805.

Indiana University-Purdue University is an equal opportunity/affirmative action employer.

Physical Oceanographer. Royal Roads Military College expects to have a tenure track vacancy in Department of Physics effective 1 July 1982. Candidates should hold doctorate or near doctorate in physical oceanography preferably with experience in digital hardware and microcomputer applications. Appointment expected to be made at assistant professor level but salary and rank dependent on qualifications and experience. Relocation expenses can be provided. Duties include undergraduate teaching in physics and physical oceanography, and research in marine science. Applications should include complete dossier and names of three references and be sent to: Dr. E. S. Graham, Principal, Royal Roads Military College, FMO Victoria, B.C. V0S 1B0.

This competition is open to both men and women. Knowledge of English only is required. Only Canadian citizens or Landed Immigrants need apply.

Toute information relative à ce concours est disponible en français et peut être obtenue en écrivant à Dr. Graham.

Oceanographer. GS-1360-12, Salary $28,245-$36,723. The Remote Sensing Branch of the Naval Ocean Research and Development Activity (NORDA) is seeking qualified applicants for the position of Oceanographer. Duties include: Serving as principal investigator for planning and organizing basic and applied scientific investigations of radio probing of the ocean surface, and interpreting the results of these investigations in terms of oceanographic parameters. Specific areas of investigation will include the detection and analysis of ocean fronts and eddies through the use of satellite-borne altimeters. Responding to Announcement No. 81-039, send a current SF-171 no later than 21 December 1981 to the Civilian Personnel Office (Code 140A), Naval Ocean Research and Development Activity, NSTL Station, MS 39529 or call 601-688-4641 for appropriate forms or additional information.

An EEO Employer.
U.S. Citizenship Required

University of Hawaii: Faculty Positions. The Department of Geology and Geophysics and the Hawaii Institute of Geophysics of the University of Hawaii are seeking applicants for two tenure track positions becoming available January 1, 1982. Applicants should have specialization in (1) *marine geophysics* with emphasis in one or more of the fields: marine seismology, magnetics and gravity; or (2) *marine geology/sedimentology*. One of these positions will be filled at a rank of full professor, the other at assistant or associate level.

Applicants should have demonstrated ability to conduct and promote marine research commensurate with the level of the application. Ability to teach at all levels is expected. The positions will be joint ones on an 11-month basis with the Department and the Institute and will involve both teaching and research responsibilities. Apply with resume, expected level of appointment and the names of 3 referees to Chairman, Personnel Committee, Department of Geology and Geophysics, University of Hawaii, Honolulu, Hawaii 96822.

Closing date for applications is January 1, 1982.

The University of Hawaii is an affirmative-action equal opportunity employer

Seagoing Research Assistant in Physical Oceanography. Applications invited for a position in the School of Oceanography, Oregon State University. B.S. in physics or engineering. Must have sea-going experience, needs some familiarity with computers and electronic instruments. Must be able to assume position by 15 February 1982. Appointee will take responsibility for deployment of a water-structure profiler on a cruise in May-June 1982; will take responsibility for preparation, calibrations, work at sea, and preparation of the data report. Salary: $20,000/yr or more depending on experience. Submit application and names of three references by 25 December 1981 to: Douglas R. Caldwell, School of Oceanography, Oregon State University, Corvallis, OR 97331.

An affirmative action/equal opportunity employer.

University of North Dakota. Applications are invited for two tenure-track appointments in the Department of Geology, beginning January 1982:

(1) petroleum geology or related fields
(2) one of the following areas
low-temperature geochemistry
carbonate petrology
economic geology

The first position will include teaching 1 or 2 courses per year in petroleum geology. Both positions require teaching undergraduate and graduate courses in the area(s) of expertise, directing graduate student research at the MS and PhD levels, and developing an active research program.

The Department has nine full-time faculty, two adjunct faculty, about 150 undergraduates and 50 graduate students. Association with the North Dakota Geological Survey includes access to complete subsurface records, cores and samples for 9,000 wells in the Williston Basin. Proximity to the Williston Basin and Canadian Shield provides abundant opportunity for research in sedimentary, igneous, and metamorphic petrology, and economic geology. Excellent physical facilities, the state core and sample library, and excellent photo, map, and book collections are available.

The Ph.D. is required, salary and rank are open and competitive. Applications will be accepted until suitable candidates are found. Applicants should submit complete resumes, including education, previous experience, teaching and research interests, and at least three letters of reference to

Dr. Richard D. LeFever
Chairman, Search Committee
Department of Geology
University of North Dakota
Grand Forks, ND 58202

Surficial Geology/Ground Water. Utah State University. Tenure track position starting spring quarter of 1982 or fall quarter of 1982. Ph.D. required. Rank and salary negotiable. Surficial geology with emphasis on geologic field studies and ground water with attention to both geologic and geohydrologic aspects. Emphasis on the arid West. Closing date November 30, 1981. USU is an affirmative action equal opportunity employer. Department of Geology (07), Utah State University, Logan, Utah 84322

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EST SERVICES. Scientific Translations From Russian to English. Specializing in Hydrology, Water Resources, and the Earth Sciences: pure research, engineering, construction, systems analysis, mathematical modeling. Experienced, extensive academic training, 15 years professional experience as a geohydrologist. Donald J. Percious, 3219 Camino del Saguaro, Tucson, Arizona 85706 (602) 743-0863.

STUDENT OPPORTUNITIES

Graduate Research Assistantships in Physical Oceanography. Opportunities for graduate study with Research assistantship available for students interested in M.S. or Ph.D. programs. A summer program with stipend is open to college juniors. Write: Douglas Caldwell, School of Oceanography, Oregon State University, Corvallis, OR 97331

Graduate Study in Oceanography/Oceanographic Engineering. Research Assistantships and research fellowships are available for graduate study in Physical and Chemical Oceanography, Oceanographic Engineering, and Marine Geology and Geophysics leading to a Ph.D. or Sc.D degree conferred jointly by the Woods Hole Oceanographic Institution and the Massachusetts Institute of Technology. The awards cover tuition and provide an average monthly taxfree stipend of $540 to $590. Research topics available to student reflect the interests of the more than 100 doctoral scientists and engineers at WHOI and the faculties of ten different departments at MIT.

The program encourages applications from students with an undergraduate degree in any of the natural sciences or engineering. For additional information please contact: The MIT/WHOI Joint Program in Oceanography/Oceanographic Engineering at either: The Education Office, The Woods Hole Oceanographic Institution, Woods Hole, MA 02543, or Room 54-911, The Massachusetts Institute of Technology, Cambridge, MA 02139.

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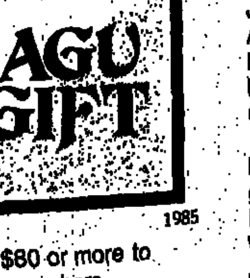

William C. Ackermann (Life Supporting Member), Keiiti Aki, L. Thomas Aldrich (Life Supporting Member), Richard J. Anderlee, Lloyd E. Brotzman, Allan V. Cox (Life Supporting Member), Anton M. Dainty, Earl G. Droessler, E. R. Engdahl, Robert S. Finn, Irene K. Fischer, Herbert Friedmann, John J. Gallagher, Jr., Samuel S. Goldich, David Greenewalt, Richard Groeber.

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Jerome Namias, Ned A. Ostenso, Barry E. Parsons, David F. Paskausky, Louis O. Quam, John C. Reed, Eugene C. Robertson, Philip B. Russell, James C. Savage, Erick O. Schonstedt, Michael Schulz, Joseph V. Smith, Waldo E. Smith, Kendall L. Svendsen, Charles V. Theis, John W. Townsend, Jr. (Life Supporting Member), James A. Van Allen, John W. Vanderwilt, Clyde Wahrhaftig, Karen M. Ward, Charles A. Whitten (Life Supporting Member), Loren D. Wicks, J. Tuzo Wilson, Frederick F. Wright, Oliver R. Wulf.

Travel Grants to IAG General Meeting

Deadline for Applications: January 1, 1982

AGU has applied to the National Science Foundation for a grant to assist the travel of individual U.S. scientists to the General Meeting of the International Association of Geodesy, to be held in Tokyo, Japan, May 7–20, 1982. Application forms for the grants are available from Member Programs Division, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009 (telephone 202-462-6903 or toll free 800-424-2488).

Meetings

Urban Hydrology

A call for papers has been issued for the Ninth International Symposium on Urban Hydrology, Hydraulics, and Sediment Control, scheduled for July 27–30, 1982, at the University of Kentucky in Lexington. Papers are solicited on urban water problems, including water runoff, storm sewer system analysis and design, sediment control, storm water management, and the analysis and management of water distribution systems. The meeting is sponsored by the university's College of Engineering, Office of Continuing Education, and the Water Resources Institute.

Papers describing case studies and comparing field and predicted results are particularly encouraged. A 250- to 500-word abstract should be submitted by December 29; invitations to submit full manuscripts will be based on the abstracts.

Mail abstracts to Beverly Stevens, Coordinator, Office of Continuing Education and Extension, 223 Transportation Research Center, University of Kentucky, Lexington, KY 40506-0043 (telephone: 606-257-3971). Address inquiries to Harry J. Sterling, Department of Civil Engineering, 206A Anderson Hall, University of Kentucky, Lexington, KY 40506-0046 (telephone: 606-257-1748).

New Listings

1982

Jan. 3–8 Annual Meeting of the American Association for the Advancement of Science, Washington, D.C. (AAAS Meetings Office, 1776 Massachusetts Avenue, N.W., Washington, DC 20036.)

May 10–12 Annual Meeting of the Canadian Geophysical Union, Downsview, Ontario, Canada. (D. E. Smylie, Department of Physics, York University, Downsview, Ontario, Canada M3J 1P3.)

May 12–19 IASPEI/UNESCO Workshop on the Theory, Observations, and Causes of Seismic Anisotropy, Suzdal, USSR. (E. M. Chesnokov, Institute of Physics of the Earth, Bolshaya Grouzinskaya 10, Moscow 123810, USSR.)

May 17–22 Fifth International Symposium on Solar-Terrestrial Physics, Ottawa, Ontario, Canada. Sponsors, SCOSTEP, COSPAR, IAGA, URSI, IUPAP. (J. G. Roederer, Geophysical Institute, University of Alaska, Fairbanks, AK 99701.)

May 23–28 Penrose Conference on Tectonic History of the Ouachita Orogen, Arkadelphia, Ark. Sponsor, GSA. (W. A. Thomas, Department of Geology, University of Alabama, University, AL 35486.)

May 26–28 16th Annual Congress and Annual General Meeting of the Canadian Meteorological and Oceanographic Society, Ottawa, Ontario, Canada. (G. Isaac, Cloud Physics Research Division, Atmospheric Environment Service, 4905 Dufferin Street, Downsview, Ontario M3H 5T4 Canada.)

June 14–17 45th Annual Meeting of the American Society of Limnology and Oceanography, Raleigh, N.C. (W. Beumeister, Business Manager, ASLO, 1530 12th Avenue, Grafton, WI 53024.)

July 14–16 National Conference on Environmental Engineering, Minneapolis, Minn. Sponsors, American Society of Civil Engineers (Environmental Engineering Division), University of Minnesota Department of Civil and Mineral Engineering, Minnesota Pollution Control Agency, Central States Water Pollution Control Association, Minnesota section of ASCE. (W. K. Johnson, Conference Chairman, Metropolitan Waste Control Commission, 350 Metro Square Building, St. Paul, MN 55101.)

July 19–30 International Association of Hydrological Sciences General Assembly, Exeter, United Kingdom. (D. E. Walling, Chairman, Local Organizing Committee, Department of Geography, University of Exeter, Amory Building, Exeter EX4 4RJ, UK.)

July 27–30 Ninth International Symposium on Urban Hydrology, Lexington, Ky. Sponsors, University of Kentucky's College of Engineering, Office of Continuing Education, Water Resources Institute. (H. J. Sterling, Department of Civil Engineering, 206A Anderson Hall, University of Kentucky, Lexington, KY 40506-0046.)

Aug. 2–6 Sixth International Symposium on the Physics and Chemistry of Ice, Rolla, Mo. Sponsors, American Physical Society, American Chemical Society, American Meteorological Society, International Commission on Snow and Ice of the International Union of Geologists and Geophysicists. (P. L. Plummer, Graduate Center for Cloud Physics Research, 109 Norwood Hall, University of Missouri, Rolla, MO 65401.)

Aug. 8–13 Penrose Conference on Origin of Fluids and Metals in Porphyry and Epithermal Mineral Deposits, Dillon, Colo. Sponsor, GSA. (J. LeAnderson, Department of Geological Engineering, Colorado School of Mines, Golden, CO 80401.)

Aug. 15–20 Penrose Conference on Models of Diagenesis in Clastic Reservoirs, Kailua, Kona, Hawaii. Sponsor, GSA. (J. R. Wood, COFRC, P.O. Box 446, La Habra, CA 90631.)

Aug. 31–Sept. 2 International Conference on the Planar and Linear Fabrics of Deformed Rocks, Zurich, Switzerland. Sponsor, Tectonic Studies Group, ETH. (J. G. Ramsay, Geologisches Institut, ETH-Zentrum, CH-8092 Zurich, Switzerland.)

Sept. 20–22 Oceans '82 Conference and Exhibition, Washington, D.C. Sponsors, Marine Technology Society, Institute of Electrical and Electronics Engineers Council on Oceanic Engineering. (Oceans '82 Technical Program Chairman, 1730 M Street, N.W., Suite 412, Washington, D.C. 20036.)

AGU CHAPMAN CONFERENCE

DISCONTINUITIES IN ROCK

May 3–6, 1982 *Santa Fe, New Mexico*

Convenors: Lawrence Teufel and Robert Riecker

Sessions planned:

- Mechanics of formation and characteristics
- Constitutive laws and deformational processes
- Geophysical phenomena
- Hydraulic properties
- Mechanical and hydraulic modeling

Those interested in attending should write to Lawrence Teufel, Geomechanics Division 5532, Sandia National Laboratories, Albuquerque, NM 87185 or call him at 505/844-7344.

Travel Grants to IAHS Scientific Assembly

Deadline for applications: March 31, 1982

AGU has applied to the National Science Foundation for a grant to assist the travel of individual U.S. scientists to the First Scientific Assembly of the International Association of Hydrological Sciences to be held in Exeter, England, July 19–30, 1982. In anticipation of favorable action by NSF, application forms for the grants are available from

American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009
(Telephone: 202/462-6903
or toll free: 800/424-2488)

Travel Grants to IMA General Meeting

Deadline for applications: April 30, 1982

The Mineralogical Society of America has applied to the National Science Foundation for a grant to assist the travel of individual U.S. scientists to the Thirteenth General Meeting of the International Mineralogical Association, to be held in Varna, Bulgaria, September 19–25, 1982. In anticipation of favorable action by NSF, application forms for the grants are available from

Mineralogical Society of America
2000 Florida Avenue, N.W.
Washington, D.C. 20009
(Telephone: 202/462-6913)

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Biographical forms can be obtained from AGI, 2000 Florida Avenue, N.W., Washington, D.C. 20009. Deadline for returning the forms is January 1, 1982.

IMS Assessment Symposium

To understand the purpose of the IMS Assessment Symposium, held at Goddard Space Flight Center, May 21–23, 1981, we should first say a few words about the International Magnetospheric Study (IMS) itself. Broadly speaking, the 'active' phase of the IMS, which ran from 1976 to 1979, was conceived as an intensive period of worldwide data acquisition on magnetospheric processes, with emphasis on closely coordinated multi-spacecraft and ground-based observations. As a result, many high-quality data sets were generated during this period from spacecraft projects, such as GEOS and ISEE, and from extensive ground arrays of magnetometers and auroral cameras. However, the mere gathering of data is obviously a futile activity in itself if the data are not then subsequently turned into science by an equally vigorously pursued period of data analysis and interpretation. Therefore, although the active phase of the IMS ended in December 1979, the IMS exercise is by no means over yet. It was to promote effective worldwide participation in the data analysis phase (DAP) that IMSAS was held. Internationally, the IMS DAP is guided by a working group convened under the auspices of SCOSTEP (the ICSU Special Committee for Solar-Terrestrial Physics), which is chaired by Gordon Rostoker (Alberta). It was with the backing of this working group that the concept that Chris Russell and David Southwood had of the IMSAS meeting came to fruition.

The specific aims of the IMS Assessment Symposium were threefold: to identify what data were obtained during the IMS for coordinated studies; to assess the status of the various workshops that were convened to facilitate such coordinated studies; and to examine the status of the problems the IMS was designed to solve. One day of the conference was devoted to each of these three aims.

In order to exploit fully the data sets that have been gathered during the IMS, and to promote interaction between the 'owners' of this data and the STP community at large, basic knowledge about this data must be generally available. To this end the first day of IMSAS was mainly devoted to reports on the 'what, when, and how' of major IMS data sets. This information will eventually be documented in the IMSAS proceedings to be published by AGU, along with the contact through whom initial approaches about the data sets can be made. Until these proceedings appear, a list has been provided (Table 1) of the names of IMSAS contributors and the data sets on which they reported.

These program reports gave rise to a number of recommendations that were adopted by the meeting participants. (1) The potential scientific value of the mid-latitude magnetometer data acquired during the IMS by the Air Force Geophysical Laboratory (AFGL) at a series of sites across the northern United States was stressed. The IMSAS meeting requested the AFGL to prepare this data in a format suitable for depositing in World Data Center (WDC)-A for STP. (2) Noting with concern that funding for the analysis of data from the USAF SCATHA (P78-2) spacecraft, launched into near-synchronous orbit in February 1979, has now been terminated, the meeting urged the rapid identification of possible funding sources for the continued reduction and analyses of SCATHA data, particularly so that the experimenters may participate in IMS data analysis workshops. (3) In view of the significant results arising from the Japanese Space Science program, the Japanese government should consider enhancing the activities of the Japanese Data Analysis Center to archive this data for future analysis. (4) It was recommended that the ISEE project prepare 5-minute average solar wind plasma and field data so that a 'high resolution' Interplanetary Data Book could be compiled by Joe King at National Space Science Data Center for the IMS period. This last recommendation will certainly have the blessing of scores of scientists worldwide, myself included, whose work in the past has depended on the existence of the previous interplanetary compendia.

The concept of close coordination of relevant data sets has been central to the philosophy of the IMS from its inception, and one of the principal mechanisms that has emerged to encourage this coordination has been the international workshop. The second day of IMSAS was therefore devoted to discussion of the results that have been obtained via IMS workshops and how such forums should be organized so as to maximize their usefulness.

The most ambitious of these programs has been the Coordinated Data Analysis Workshops (CDAW). After topic and event selection, the various data sets are assembled together in a common format on an interactive computer facility.

So far, four such analysis workshops have been held on IMS topics. CDAW 1 and 2 were event-oriented workshops studying the magnetospheric disturbances occurring in December and July 1977, respectively. These meetings served to establish the basic ground rules and physical arrangements necessary to run workshops of this type. By contrast, CDAW 3 and 4 were oriented toward particular physical problems (the earth's bow shock and dayside magnetopause, respectively) rather than particular dates or events, and this seems to have worked somewhat better, although with a much more restricted contributing community. It was recognized that preplanning the CDAW and then holding it are simply not enough. Follow-through analysis to achieve definite conclusions and publications is essential, but has not always occurred. CDAW 4 had a follow-up workshop in Garching, Federal Republic of Germany. However, it did not have remote terminal access to the Goddard Data Analysis Workshop Center (DAWOC). A further possible solution would be to set up the means for individual experimenter remote access to the DAWOC, much as might be envisaged in the future for the AMPTE and OPEN programs. Taken to its logical extreme, this might seem to lead to the conclusion that the CDAWs, as such, would not then be necessary. However, it was stressed by many IMSAS participants that direct personal contact is a very important aspect of collaboration and of any workshop format.

The regional IMS workshops organized in Japan and Europe were also outlined at the meeting. In many respects these have been organized much more along the lines of regular scientific discussion meetings, with contributed papers and without the technological back-up of the CDAW. However, the next European IMS workshop, to be held in Denmark in October 1981, will be integrated into the planning phase of the next CDAW, with interest centered on observations of the CDAW events made with the GEOS spacecraft.

Finally, the program focused on the scientific progress made during the IMS and on the identification of areas in which significant problems remain which could be addressed with the IMS data sets. Eleven review papers were presented covering a broad range of topics, including active experiments in the magnetosphere and ionosphere and computer simulations. These papers have been submitted to *Reviews of Geophysics and Space Physics* and should appear in middle 1982.

To any individual working in a particular scientific field, progress may seem somewhat slow and halting. However, in looking backward to the beginning of the IMS period, one could be astonished to see how far we have traveled. A list of significant achievements during the IMS is bound to reflect personal interests. However, my list of highlights would certainly include the increasing awareness of the ionosphere as a source of magnetospheric plasma, which has arisen from a first generation of mass discriminating plasma instruments on such spacecraft as S3-3, GEOS, ISEE, SCATHA, and, most recently, PROGNOZ; the first high-resolution measurements of the dayside magnetopause and plasma sheet boundary layer regions with ISEE, where the signatures of magnetic reconnection appear to have been so clearly seen; and the increasing use of ground-based radar techniques, including both incoherent scatter and STARE-type radar aurora systems. One is bound to conclude from the IMSAS reviews that the IMS period has already been very successful in scientific terms. At the same time it is also clear that perhaps only the surface layers of the IMS data sets have as yet been touched. I leave it to the reader to formulate his or her own list of outstanding questions that can be addressed with them!

This meeting report was prepared by Stanley W. H. Cowley of the Imperial College of Science and Technology, London.

TABLE 1. Contacts

Author	Affiliation	Data Set	Region
		Spacecraft Data Sets	
T. von Rosenvinge	GSFC	ISEE-3	interplanetary observations
J. King	GSFC	IMP 7/8	interplanetary observations
B. Hultqvist	Kiruna Geophys. Inst.	Prognoz 7/8 (Promics experiment)	outer magnetosphere
K. Ogilvie	GSFC	ISEE-1	outer magnetosphere
V. Formisano	ESTEC	ISEE-2	outer magnetosphere
K. Knott	ESTEC	GEOS	synchronous orbit
T. Fritz	SEL, NOAA, Boulder	ATS 6/SMS/GOES	synchronous orbit
D. Baker	LANL	LANL Synoptic Data Set	synchronous orbit
J. Fennell	Aerospace Corp.	SCATHA (P78-2)	near synchronous
T. Obayashi	Tokyo Univ.	Japanese IMS spacecraft, Kyokko, Jikiken	various
C. Cattell	Univ. of Calif., Berkeley	S3-3/S3-2	low altitude
H. Kroehl	EDS, NOAA, Boulder	DMSP	low altitude
N. Spencer	GSFC	Atmospheric Explorer	low altitude
R. Langel	GSFC	Magsat	low altitude
M. Teague	GSFC	Satellite Situation Center	—
		Ground-Based Data Sets	
R. Pellinen	Finnish Meteorol. Inst.	CCOG	Northern Europe
W. Baumjohann	IFG Muenster	German IMS networks	Scandinavia
W. Stuart	IGS Edinburgh	UK IMS magnetometers	Scandinavia, Iceland Faroes, U.K.
E. Nielsen	MPI Lindau	STARE radar	Scandinavia
T. Murayama	Nagoya Univ.	Japanese data sets	Japan
R. McPherron	Univ. of Calif., Los Angeles	US mid-lat. magnetometers	North America
G. Rostoker	Univ. of Alberta	auroral zone instrument arrays	North America
R. Vondrak	SRI	Incoherent scatter radar data	Chatanika, Millstone Hill etc.
T. Rosenberg	Univ. of Maryland	U.S. Antarctic Program data	Antarctica
T. Nagata	NIPR Tokyo	Japanese Antarctic Program data (Soyowa)	Antarctica
M. Rycroft	British Antarctic Survey	U.K., Australian, N.Z., Soviet, French, South African Antarctic Programs	Antarctica

Abbreviations: GSFC, Goddard Space Flight Center; ESTEC, European Space Research and Technology Centre; SEL, Space Environment Laboratory; LANL, Los Alamos National Laboratory; EDS, Environmental Data Service; IFG, Institut für Geophysik der Universität Münster; IGS, Institute of Geological Sciences; MPI, Max Planck Institut für Aeronomie; SRI, Stanford Research Institute; NIPR, National Institute of Polar Research.

GAP

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Washington, D.C. 20009

Oceanography

4705 Boundary layer and exchange processes
TERMS GOVERNING TEMPERATURE AND THICKNESS OF THE OCEANIC MIXED LAYER AND THEIR ESTIMATES FOR SEA AREA SOUTH OF JAPAN
Z. Kanaya (Geophysical Institute, Faculty of Science, Tohoku University, Sendai 980, Japan) and Y. Toba

Governing equations of temperature and thickness of the oceanic mixed layer have been formulated using a slab model which allows horizontal inhomogeneities of temperature, velocity and thickness of the mixed layer. Using the terms included in the above equations, a brief classification of physical processes of the upper ocean has been made. The orders of magnitude of terms in the equations are estimated for the sea area south of Japan (the area near the OWS-Tango), synthesizing published data and past investigations. When the time and spatial scales of 100 days and 1000 km, respectively, are selected (for the regional sea scale), the temperature change of the mixed layer is found to be mainly due to net heat exchange through the sea surface, entrainment at the bottom of the mixed layer and to horizontal mixing, whereas for a smaller scale such as the synoptic scale, horizontal advection becomes significant rather than horizontal mixing. In either case, the above results suggest that three-dimensional processes are important in the variation of the mixed layer in the area adjacent to the Kuroshio. (Oceanic mixed layer, sea surface temperature, heat flux, Kuroshio).
Sci. Rep. Tohoku Univ., Ser. 5 (Tohoku Geophys. Journ.), Vol. 28, No. 3, 1981

4710 Chemical oceanography
DISTRIBUTION OF THORIUM ISOTOPES BETWEEN DISSOLVED AND PARTICULATE FORMS IN THE DEEP SEA
M. P. Bacon (Woods Hole Oceanographic Institution, Woods Hole, Mass. 02543) and R. F. Anderson

[illegible]

J. Geophys. Res., Green, Paper 1C1678

4713 Circulation
A NOTE ON THE LATITUDE OF THE CONFLUENCE ZONE OF THE KUROSHIO AND THE OYASHIO
T. Sekine (Geophysical Institute, Faculty of Science, Tohoku University, Sendai 980, Japan)

A numerical study on the latitudinal location of the confluence zone of the Kuroshio and the Oyashio, the two western boundary currents of the North Pacific Ocean, is done by use of a simplified homogeneous model. [illegible]

Sci. Rep. Tohoku Univ., Ser. 5 (Tohoku Geophys. Journ.), Vol. 28, No. 3, 1981

4720 Distribution and water masses
SPACE/TIME STATISTICS OF THE BAROCLINIC GYRE STRUCTURE OF THE WESTERN NORTH PACIFIC
W.B. White (Scripps Institution of Oceanography, University of California, San Diego, CA 92093) and G. Meyers

Temperature data routinely taken over a period of years are used for information of the space/time statistics of the gyre scale variability in the western North Pacific. The data were taken by the RV RYOFU MARU, making winter hydrographic transects [illegible]

[illegible]

4720 Distributions and Water Masses
COASTAL FRESH WATER DISCHARGE IN THE NORTHEAST PACIFIC
Thomas C. Royer (Institute of Marine Science, University of Alaska 99701)

[illegible]

J. Geophys. Res., Green, Paper [illegible]

4750 Physical properties of seawater
THE THREE-PARAMETER MODEL OF THE SUBMARINE LIGHT FIELD: RADIANT ENERGY ABSORPTION AND ENERGY TRAPPING IN NEPHELOID LAYERS

[illegible]

4763 Surface waves, tides, and sea level
ATTENUATION OF WIND WAVES BY ARTIFICIAL SURFACE FILMS OF DIFFERENT CHEMICAL STRUCTURE

[illegible]

4765 [illegible]

[illegible]

4780 Instruments and Techniques

[illegible] within the evaluation procedure used for validation and accuracy assessment.
J. Geophys. Res., Green, Paper 1C1647

Particles and Fields—Ionosphere

5515 Auroras
ANOMALOUS RESISTIVITY ON AURORAL FIELD LINES
H. L. Rowland (Department of Physics and Astronomy, University of Maryland, College Park, MD 20742), P. J. Palmadesso and K. Papadopoulos

A classic problem in laboratory and space plasma physics is the existence of field aligned potential drops in strongly magnetized ($\omega_{pe} < \omega_{ce}$) collisionless plasmas. Even in the presence of effects that would generate strong anomalous resistivity in an unmagnetized plasma, the invariance of the magnetic moment, μ, of the electrons will result in runaway. We demonstrate by theory and computer simulations that the adiabaticity of μ for electrons accelerated above a certain critical velocity breaks down due to the anomalous Doppler resonance instability. This along with some recent concepts of strong turbulence allows us to present a coherent theory of anomalous resistivity and electron acceleration, which fits the observed distribution of energetic electron fluxes. In the presence of ion density fluctuations with $\delta n/n_o > 0.2$ such as observed in the auroras, the electron response to a field aligned potential occurs in three stages. The first stage is one dimensional and a long, flat tail forms on one side of the electron distribution as the electric field separates untrapped electrons and electrons nonlinearly trapped by the ion fluctuations. When the electrons reach a critical velocity for the onset of the anomalous Doppler resonance instability, the current is clamped and the electrons are heated in the perpendicular direction. Until the tail electrons are heated such that $T_\perp \approx T_\parallel$ the current does not increase and one sees a strong resistivity. On longer time scales the behavior of the system depends upon the loss rate of the electrons with large perpendicular velocities.
Geophys. Res. Lett., Paper 1L1709